Review of Academic Mathematics Instruction for Students with Mild Intellectual Disability

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Abstract: Mathematics education—like all education—faced changes in recent years including increasing expectations, and these expectations have impacted all students, including students with mild intellectual disability. To explore the impact of the changes on mathematics education on students with mild intellectual disability, the authors reviewed the literature from 1999–2010 on academic mathematics interventions for students with mild intellectual disability. Of the seven articles found, the majority focused on interventions designed to improve knowledge of mathematical facts and computational procedures. One study included an intervention involving metacognition and diagramming of mathematical relationships to help students solve word problems. Results suggest a dissonance between the mathematics focus of mathematics professional organizations and federal and state policies regarding higher order mathematics and perhaps current practice for students with mild intellectual disability, as reflected in the research literature.

Mathematics education is a core content area with direct benefits for advanced education and employment for all students (Algozzine, O'Shea, Crews, & Stoddard, 1987; Maccini, McNaughton, & Ruhl, 1999; National Council of Teachers of Mathematics [NCTM], 2000; No Child Left Behind [NCLB], 2002; Xin, Jitendra, & Deatline-Buchman, 2005). Although mathematics education has always been important, its stake in education has risen over the past few decades. Recent federal education laws mixed with rising expectations of national professional organizations and changes in educational policy altered what is expected of all students, including students with disabilities (NCTM; NCLB; Teuscher, Dingman, Nevels, & Reys, 2008; Woodward, 2004).

The latest reauthorization of the Elementary and Secondary Education Act (ESEA)—called No Child Left Behind (NCLB, 2002)—required all students to participate in each state’s accountability system, meaning students were to be tested annually in grades 3–8 and once again in high school in reading, mathematics, and science. Further, schools were to show Adequately Yearly Progress (AYP) to account for all students’ improvement as well as that of particular subgroups, such as students with disabilities, on their state’s accountability system (i.e., typically the large-scale general assessment in the reading, mathematics, and science) (Yell & Drasgow, 2005). Not only were students with disabilities included in the general education law but also the latest reauthorization of Individuals with Disabilities Education Act (IDEA, 2004) aligned itself with NCLB regarding students with disabilities participating in the accountability system as well promoting access to the general education curriculum (Turnbull, Huerta, & Stowe, 2006).

Also contributing to rising expectations for students with disabilities in mathematics education were changes in high school graduation requirements, including exit exams (Ysseldyke et al., 2004) and mandated upper level mathematics classes (Teuscher et al., 2008), as well as increasingly rigorous content area standards proposed by professional organizations (e.g., NCTM, 2000) and the recent Common Core Standards (Council of Chief State School Officers and National Governors Association, 2010). Exit exams, affecting 28 states as of 2010, require a student to pass a
test to graduate from high school; failure can result in a certificate of attendance rather than a diploma (Center on Education Policy [CEP], 2010; Reardon, Arshan, Atteberry, & Kurlaender, 2010). Regarding courses in high school, some states now require students to pass high school algebra and/or geometry to earn a diploma (Mack 2010; Teuscher et al.). Beyond the NCTM standards, typically adopted by states for their grade level mathematics standards, 2010 resulted in a majority of states adopting the Common Core standards for all students (CCSSO and NGA Center, 2010). The Common Core addresses standards for students in grades K-12 in expanded literacy and mathematics and focus on college and career readiness (CCSSO & NGA).

**Students with Mild Intellectual Disability**

Given the increased emphasis on not only mathematics education but also rigorous mathematics education for all students, one must question how much access to the general education curriculum and what type of instruction are students with disabilities receiving. Increasing expectations for higher standardized test scores for students with disabilities, including students with mild intellectual disability (MID), not only led to intense pressure for teachers to help students raise test scores, but also a need for researchers to develop interventions for helping students with MID and their teachers respond to the pressure for high test scores (Maccini, Mulcahy, & Wilson, 2007; Popham, 2001; Woodward, 2004). More importantly, it is necessary to understand the access students with MID are being given to the general education curriculum to determine if these students are being given an opportunity to leave K-12 education with the procedural and conceptual understanding of mathematics they need be successful in postsecondary (i.e., academic, occupational, or daily living) settings and as participating citizens in a democracy (Cohen, 1999; Lesh, Post, & Behr, 1988; NCTM, 2000; Patton, Cronin, Bassett, & Koppel, 1997; Vergnaud, 1983).

In the United States, a student with MID is an individual who has "significantly subaverage general intellectual functioning, existing concurrently with deficits in adaptive behavior and manifested during the developmental period, that adversely affects a child’s educational performance” (IDEA, 2004). According to Polloway, Patton, Smith, and Buck (1997) students with MID experience “related limitations in two or more of the following applicable adaptive skill areas: communication, self-care, home living, social skills, community use, self direction, health and safety, functional academics, leisure, and work” (p. 298). In schools, students with MID typically have IQs between 55 and 70, although the American Association on Intellectual and Developmental Disabilities (2011)—a major organization in the United States that advocates for individuals with intellectual disability—classifies individuals with IQs between 50 to 75 range as having MID (Bouck, in press).

Researchers identified general characteristics of students with MID including slow academic growth, low academic performance, and poor post-secondary outcomes (Parmar, Cawley, & Miller, 1994; Sabornie, Evans, & Cullinan, 2006). Researchers hypothesized some of these difficulties are likely due to challenges students with MID face in working memory, particularly with storing information (Allen, Baddeley, & Hitch, 2006; Baddeley, 2003; Schuchardt, Gebhard & Mächler, 2010). While some information is available for understanding students with MID, often in research students with MID are aggregated with students with moderate and severe intellectual disability or with students with other high incidence disabilities such as learning disabilities and emotional/behavior disorders (Polloway, Lubin, Smith, & Patton, 2010). Practitioners and researchers would benefit from more disaggregated data on students with MID regarding characteristics, interventions, and outcomes specific to this population.

**Mathematics Instruction for Students with MID**

Historically, mathematics instruction for students with MID has been divided into two main areas, not unlike the general dichotomy of curriculum for this population of students: a functional curriculum and an academically-oriented approach (Alwell & Cobb, 2009; Browder, Spooner, Wakeman, Trela, & Baker, 2006). Although a recent review exists on functional mathematical curriculum received
by students with intellectual disability (note, not disaggregated for students with MID) (Browder, Spooner, Ahlgrim-Delzell, Harris, & Wakeman, 2008), the last thorough review on academic mathematical instruction for students with mild-to-moderate intellectual disability predates the current decade and hence current reforms (Butler, Miller, Lee, & Pierce, 2001).

Butler and colleagues (2001) reviewed the literature on mathematics education for students with mild-to-moderate intellectual disability published between 1989 and 1998. In the 16 articles found for these two populations during the time frame, Butler et al. found a shift in instructional focus from a curriculum based on basic skills (e.g., numeracy, mathematical symbols, equality, etc.) to a focus on computational fluency and mathematical problem solving (e.g., tasks involving organization and analysis of information). Further, Butler et al. noted the increased attention to developing students’ procedural and conceptual understanding, such as research supporting teaching students with mild-to-moderate intellectual disability through use of strategy instruction for problem solving, self-regulation, and the concrete-semiconcrete-abstract teaching sequence. The shift in instructional methods coincided with recommendations for shifting emphasis in mathematics education in general, as supported by the National Council of Teachers of Mathematics (1989) as well as supported the position of researchers in special education who called for greater attention to problem-solving and the development of conceptual understanding (e.g., Jitendra & Xin, 1997; Woodward & Howard, 1994).

The shifting emphasis of instructional methods for students with intellectual disability also aligned with research suggesting students with MIDE have strengths in mathematics regarding higher level thinking skills, such as the ability to create and maintain strategies, utilize metacognitive skills, and develop at least some levels of conceptual understanding of mathematical relationships on an abstract level (Baroody, 1996; Erez & Peled, 2001). In a group study including twenty-four elementary, middle, and high school students with mild-to-moderate intellectual disability, some students were able to independently create more efficient strategies (e.g., short-cuts such as “counting on”) after receiving explicit instruction for less efficient, more time-consuming strategies (e.g., “counting all”) when working on single digit addition problems (Baroody). Erez and Peled also found some middle and high school students with mild-to-moderate intellectual disability used metacognitive skills, such as reexamining choices made during problem solving processes and basing future actions upon these reflections, to solve addition word problems. Some of these students also independently developed an understanding of the structure of these problems and the abstract mathematical relationships within the problems (e.g., part-part-whole) (Erez & Peled).

While schools are expected to prepare students with MID for daily responsibilities once they leave K-12 education, students with MID also need a variety of mathematical skills to meet demands placed upon them by educational laws (i.e., IDEA, 2004; NCLB, 2002) and high school graduation requirements (Teuscher et al., 2008). Students with disabilities, including students with mild intellectual disability, need access to opportunities to develop conceptual understanding for success with more complex mathematics in middle school, high school, and post-secondary education (Lesh et al., 1988; Vergnaud, 1983; Woodward & Montague, 2002). While Butler et al. (2001) indicated students with MID were receiving instruction more rooted in mathematical concepts than in previous years, the question remains regarding whether students with MID continued to receive instruction needed to develop the foundation in mathematics for success when considering both procedural and conceptual understanding. The specific research question for this study is: What is the nature of the academic instruction the students with MID have received in mathematics in the past 11 years?

Method

A systematic review of the literature was completed of academic mathematics interventions for students with MID from 1999 to 2010. The researchers chose this period of time as Butler et al. (2001) reviewed research on this topic through 1998 and multiple reforms impacting mathematics education occurred in the last decade (e.g., Common Core Standards, 2010; IDEA, 2004; NCTM, 2000). Studies were in-
cluded if (a) the sample included at least one student with MID enrolled in school (i.e., a student between the ages of 3 and graduation or exiting school and was referred to as a student with MID by the authors of the study and/or the IQ reported in the study was between 50 and 75); (b) the study focused on an academic mathematics intervention, operationally defined as an intervention targeting a skill area for advancement in school mathematics rather than daily living skills such as purchasing groceries or counting money; (c) the article was published in a peer-reviewed journal in English between 1999 and 2010; and (d) the research occurred in the United States. Common reasons articles were excluded included (a) the description of the participants was unspecified; (b) the data for participants with MID were aggregated with data for other disabilities and could not be isolated; (c) the term MID (or something equivalent) was used by the authors, but all participants had IQs outside of the 50–75 range; and/or (d) the studies were conducted in foreign countries where MID is defined differently (often with IQs up to 85) (e.g., Kroesbergen & Van Luit, 2005). Articles focused on assessment (e.g., identification of students for special education services); descriptions of characteristics of students with disabilities; and position papers were also excluded.

Multiple methods were used to locate articles meeting the criteria. First, a keyword search was completed utilizing four electronic databases: PsychInfo, ERIC, Wilson Select, and ProQuest. Due to the number of terms used synonymously with MID, articles that used the terms mild mental retardation, developmental disability, cognitive disability, mild intellectual disability, and mild cognitive impairment were included in the study (Sandieson, 1998). For the keyword search, math* was combined with the following terms: mental impairment, mild cognitive, mild intellectual, mild mental retardation, and mild developmental. The researchers also used the search terms, intellectual and cognitive disab*, and evaluated the IQ of the participants within these studies.

Next, the researchers reviewed both general and special education journals for articles meeting the criteria published between the years 1999 and 2010. A hand search was completed by looking for relevant articles in the following journals: Journal for Research in Mathematics Education, Exceptional Children, The Journal of Special Education, Remedial and Special Education, and Education and Training in Autism and Developmental Disabilities. During the hand search, the researchers evaluated articles by looking for the search terms described above as well as any terms that might be relevant to this study (e.g., students with mild disabilities, math difficulties, etc.), but not specifically included in the search terms in the computer database search. Finally, the researchers completed an ancestral search using the references of the articles meeting criteria for inclusion in this study. All of the articles were located in electronic databases using keyword searches except for one article which was located by hand-searching the selected journals. The ancestral search did not result in finding any articles that met inclusion criteria.

Results

Seven studies were found addressing academic mathematics interventions for students with MID published between the years 1999 and 2010 (see Table 1). The participants ranged in ages from children in elementary school to a 23-year-old adult in an after high school program. The majority of the studies on mathematics instruction and students with MID (i.e., six of seven) were focused on procedural instruction; in other words, mathematics facts or computation involving basic arithmetic (e.g., addition, subtraction, multiplication, and division facts and traditional algorithmic procedures). The other study–focused on conceptual instruction–involved an intervention based on the use of mathematical models, prompts for cognition/meta-cognition related to problem structure and algebraic procedures for solving word problems.

Procedural Instruction

Flashcards. Flashcards were used in four of the six studies focused on procedural instruction, each designed to improve the mathematical fact knowledge of students with MID (Dihoff, Brosvic, Epstein, & Cook, 2005; Hayter,
Scott, McLaughlin, & Weber, 2007; Rao & Mallow, 2009; Sante, McLaughlin, & Weber, 2001). Sante and colleagues conducted a single subject design study focused on improving multiplication facts that included two sixth-grade participants with MID and ADHD. Both

<table>
<thead>
<tr>
<th>Citation</th>
<th>Intervention</th>
<th># of Subjects with MID</th>
<th>Setting</th>
<th>Design</th>
<th>Results</th>
</tr>
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<tbody>
<tr>
<td>Sante, McLaughlin, &amp; Weber</td>
<td>Flashcards for learning multiplication facts</td>
<td>2</td>
<td>Middle school self-contained classroom</td>
<td>Multiple baseline across participants</td>
<td>Students’ rate of accuracy with multiplication facts improved.</td>
</tr>
<tr>
<td>Neef, Nelles, Iwata, &amp; Page</td>
<td>Meta-cognitive and model-based instruction for addition and subtraction word problems</td>
<td>1</td>
<td>After high school program for students with intellectual disabilities</td>
<td>Multiple baseline across behaviors</td>
<td>Student’s word problem solving performance improved.</td>
</tr>
<tr>
<td>Dihoff, Brosvic, Epstein, &amp; Cook</td>
<td>Students received feedback from the teacher while completing multiple choice questions in response to flashcards</td>
<td>55</td>
<td>Elementary school</td>
<td>Group comparison</td>
<td>Students’ retention of arithmetic facts (addition, subtraction, multiplication &amp; division) improved. The skills learned were maintained by the participants for about one-to-two weeks.</td>
</tr>
<tr>
<td>Hayter, Scott, McLaughlin, &amp; Weber</td>
<td>Flashcards for learning multiplication facts</td>
<td>2</td>
<td>High school self-contained classroom</td>
<td>Multiple baseline across participants</td>
<td>Students showed higher motivation and improved accuracy on multiplication facts.</td>
</tr>
<tr>
<td>Bouck, Bassette, Taber-Doughty, Flanagan, &amp; Szwed</td>
<td>Pentop computer for teaching multiplication computation</td>
<td>3</td>
<td>Middle school self-contained classroom</td>
<td>Multiple baseline across participants</td>
<td>Students’ performance with multiplication computation improved and was maintained by the participants.</td>
</tr>
<tr>
<td>Rao &amp; Mallow (2009)</td>
<td>Simultaneous prompting system for automatic recall of multiplication facts</td>
<td>1</td>
<td>Middle school self-contained classroom</td>
<td>Multiple baseline across participants</td>
<td>Students’ accuracy and speed for recalling multiplication facts improved and was maintained and generalized.</td>
</tr>
<tr>
<td>Rao &amp; Kane (2009)</td>
<td>Simultaneous prompting system for regrouping during decimal subtraction</td>
<td>2</td>
<td>Middle school self-contained classroom</td>
<td>Multiple baseline across participants</td>
<td>Students maintained and generalized the skill of successful decimal subtraction procedures.</td>
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</table>
participants performed at a third-grade mathematics level and were educated in a self-contained special education mathematics class. The researchers found sixteen-to-seventeen sessions of presenting flashcards with one digit factors and providing feedback regarding correctness of answers improved the multiplication factual knowledge of the students, and the researchers recommended using this approach to enhance mathematical performance.

Hayter and colleagues also used a single subject research design to study the impact of flashcards (containing factors ranging from four to ten) followed by informing the student of the answer on helping high school students with MID learn multiplication facts. After eleven sessions, the researchers reported an increased accuracy with multiplication facts and, after the participants experienced success, their motivation to solve the tasks improved. After the participants were encouraged by their success, they made their own flashcards for studying for another class.

Also using a single-subject research design, Rao and Mallow (2009) evaluated flashcards as an intervention to help a middle school student with MID learn multiplication facts, but combined the visual aspect of flashcards with teacher prompts (i.e., the teacher provided the answer along with the presentation of the flashcard). The intervention supported growth in the participant’s factual knowledge of multiplication facts with factors ranging from zero to twelve, and improved his speed and accuracy. The participant was able to maintain his knowledge of multiplication facts for over a three-month period and made generalizations to situations when the student needed to recall multiplication facts while solving long division problems using a traditional algorithm as well as from the special to the general education classroom.

The final flashcard study involved a group comparison of 55 elementary school students with MID (Dihoff et al., 2005). Dihoff et al. used flashcards with multiple choice answers listed on the flashcards to fact questions for addition, subtraction, multiplication, and division. The researchers prompted elementary school students with MID when incorrect to consider the alternative choices on the flashcards. In some situations, the researchers provided similar prompts using a bubbled answer sheet with wax covers over each answer choice. After students removed the wax coating of their answer choice, a star under the wax coating indicated correct answer while a lack of a star prompted the participants they were incorrect. In both cases, the participants were able to keep making choices until they found the correct answer. The participants were able to retain the knowledge they gained from the practice along with the prompts and feedback for time periods ranging from five days to two weeks.

**Computational instruction.** In one of two studies focused on computation instruction, Rao and Kane (2009) used a single subject design to study teacher prompts for two middle school students with MID to follow procedures for using traditional algorithms for subtracting decimals. The participants were given step-by-step instructions for each procedure involved (e.g., recognizing the need for regrouping as well as how to complete the regrouping procedures). The skills for completing the traditional algorithm for subtracting decimals were maintained for the remainder of the school year and generalized to subtraction problems with different regrouping requirements and to real-world situations such as using a spreadsheet for solving money-related problems associated with personal finances and business budgets.

In another single subject study, Bouck, Bassette, Taber-Doughty, Flanagan, & Szwed (2009) used technology as an intervention to improve participants’ computational knowledge. Bouck and colleagues evaluated the FLYPen™–a pentop computer produced by LeapFrog™–as a tool to improve the multiplication fluency of three middle school students with MID. The technology benefited students with both learning multiplication facts as well as multiplication computation skills with involving a single-digit numbers and two-digit numbers (e.g., $35 \times 7$). The immediate feedback students received from the technology when they made a mistake was noted as helping students.

**Conceptual Instruction**

In the one conceptual instruction study, Neef, Nelles, Iwata, & Page (2003) used a single
subject design to provide an intervention for two students—one student with MID—on how to solve addition and subtraction word problems. Neef and colleagues described their intervention as teaching precurrent skills (i.e., “responses that increase the effectiveness of a subsequent or ‘current’ behavior in obtaining a reinforcer,” p. 21). The participants placed mathematical signs and problem elements in a mathematical model that included a box for each number or variable in the problem, the mathematical operations sign, and the equal sign. After placing the known problem elements and correct mathematical signs in the model, the participants were instructed to use basic algebraic procedures to solve for the unknown in simple equations such as “A + ? = C” (p. 25). Students were encouraged to think about the structure of the problem via prompting from the teacher such as “How many objects did (name) start out with, end up with, get, lose, etc.” (p. 27). The participants’ word problem solving accuracy improved after receiving the intervention. Maintenance of skills was not tested by the researchers due to time constraints nor was the generalization of the skills to other problem types.

Discussion

Given the current emphasis on mathematics education for all students, including students with MID, it is imperative to determine the nature of existing research on mathematical interventions for these students and use this knowledge to inform further practice and research. This study focused on research in the past decade involving academic mathematical interventions for students with MID—a population lacking in attention (Polloway, 2006; Polloway et al., 2010)–from age three to exiting school. The results suggest two main findings: (a) little attention in research to academically-based mathematical interventions for students with MID with no current studies focusing on mathematics standards at or above middle school levels of general education curriculum, and (b) of the limited existing research, most studies are primarily focused on procedural instruction (e.g., mathematical facts and computational fluency) rather than conceptual understanding (e.g., problem-solving).

The limited research on mathematics education for students with MID is discouraging although perhaps not surprising. Even though mathematics received increased attention in the past decade due the educational climate (e.g., NCLB, 2002), historically less research has been conducted on students with disabilities and mathematics than literacy (Fuchs & Fuchs, 2005; Fuchs et al., 2007). The lack of attention in the last decade to mathematics education and students with MID is problematic for multiple reasons, including difficulty in articulating evidence-based mathematical practices for this population without a research base as well as the dissociation with current practice and policy regarding the importance of mathematics education, especially rigorous mathematics education for all students (IDEA, 2004; NCLB, 2002; NCTM, 2000; Woodward, 2004). Clearly, this systematic review highlights the need for more research in academic mathematical intervention for students with MID, although from the existing recent research we can gleam the prioritized pedagogical approaches.

Procedural and Conceptual Instruction

Within the limited existing research on mathematics for students with MID, the majority (n=6) focused on procedural instruction rather than conceptual understanding. In other words, current research prioritized the memorization of mathematical facts or steps taken to complete mathematics problems (e.g., using a traditional algorithm) rather than understanding mathematical concepts and using reasoning skills to make and explain decisions made during problem solving processes (NCTM, 2000). The lack of attention in research to conceptual understanding for this population of students is also at odds with the current mathematics policy, educational reforms, and recommendations by general and special education researchers (Lesh et al., 1988; National Math Advisory Panel Report, 2008; NCTM, 2000; Ostad, 1998; van Garderen, 2007; Vergnaud, 1983; Woodward, 2004; Woodward & Montague, 2002). Special education researchers have recommended greater emphasis on developing critical think-
ning skills about mathematics and deeper conceptual understanding of mathematical ideas to empower students with knowledge that is transferable to various situations rather than knowledge of procedures specific to certain mathematical situations (van Garderen, 2007; Woodward & Montague, 2002). Mathematical reasoning and conceptual understanding can help students achieve higher levels in mathematics and face increased expectations for academic performance in K-12 education (IDEA, 2004; NCLB, 2002; NCTM, 2000; Woodward, 2004).

While some might question the need for more rigorous focused mathematics education for students with MID, it is imperative for multiple reasons: (a) these students are capable of being successful with these pedagogical approaches if given a chance (Baroody, 1996; Jimenez, Browder, & Courtade, 2008; Erez & Peled, 2001; Neef et al., 2003), (b) a decreased focus on procedures or rote recall is consistent with research suggesting students with MID struggle with working memory (Schuchardt et al., 2010), and (c) helping these students to be successful on high-stakes assessments (NCLB, 2002; Woodward, 2004). First, although limited in quantity, the little research on more conceptual instruction for students with intellectual disability demonstrated success. Neef et al. taught students with MID how to use basic algebraic procedures (e.g., solving for the unknown) while solving word problems. Related, in a study by Jimenez et al., students with IQs below 50 were successful with solving for an unknown in an algebraic equation (e.g., \(3 + a = 5\)). These findings, when considered along with those of Baroody (1996) and Erez and Peled (2001), suggest students with MID possess a number of skills related to higher order mathematical understanding and the field may need to raise its expectations for what these students can—and should be expected—to do.

Second, students with MID struggle with working memory (Schuchardt et al., 2010). Rather than focus on instructional approaches steeped in storage and recall, practitioners can focus on conceptual understanding and use technology to circumvent student struggles (NCTM, 2000; Woodward & Montague, 2002). Students with MID experience success using calculators (Bouck et al., 2009; Horton, Lovitt, & White, 1992). Calculators can be used as a cognitive prosthesis (Edyburn, 2006) and teachers can then potentially devote more instructional time to developing a thorough and deep understanding of mathematical ideas and connections between those ideas—instruction consistent with recommendations by NCTM (2000) and even special education researchers (Woodward & Montague).

Last, higher level mathematical ability and understanding is needed by students with MID if they are expected to take general large-scale assessment (Bouck, 2007). Given that students with MID across all grade levels typically take the same assessment as their peers without disabilities (Bouck; Yell & Drasgow, 2005; Ysseldyke et al., 2004), instruction in mathematics for this population needs to focused on the areas that can promote student success. If these students are expected to take the general large-scale assessment, they should be given general education academic instruction to increase the opportunity for success (Bouck, 2007). While assessment should not drive instructional practice (Faulkner & Cook, 2006; Shepard, 2010), students with MID have to be given a fighting chance to be successful by covering the content. Hence, research should focus on how to help students with MID be successful in mathematics classes if the field of education continues the practice of high stakes testing.

Implications for Practice

The results of this review of the literature suggest practices exist that assist students with MID in ascertaining basic facts as well as conceptual understanding of mathematical ideas, although more research is needed on the latter. Multiple studies in the review suggest teachers can rely on flashcards as an educational tool for teaching mathematical facts to students with MID (Dihoff et al., 2005; Hayter et al., 2007; Rao & Mallow, 2009; Sante et al., 2001). However, teachers need to make careful decisions about how much time is devoted to memorization of facts as compared to critical thinking about mathematical ideas and the connections between these ideas (NCTM, 2000; van Garderen, 2007; Woodward & Montague, 2002).
Neef and colleagues (2003) demonstrated some of the benefits of diagramming information in word problems. Diagramming and other forms of visual representation may also be included in instruction to give students with MID opportunities for access to more challenging mathematics (van Garderen, 2006). By teaching students with MID methods for storing information on paper while working through challenging, multistep problems, teachers give these students an important tool for overcoming deficits in working memory which may have previously contributed to the struggles of some students with MID in mathematics (Allen et al., 2006; Baddeley, 2003; Barrouillet, Bernardin, Portrat, Vergauwe, & Camos, 2007; Schuchardt et al., 2010). Instructional principles applied by Neef and colleagues may be also applicable to various situations in which students with MID are likely to need help with storing and organizing information and using metacognition to complete proper analysis of the mathematical problem and the steps taken to solve it. Teachers can apply these principles to multiple mathematical situations as well as in other content areas when students with MID feel overwhelmed with the amount and complexity of information they need to store, organize, and process.

Limitations and Future Directions

A challenge exists when studying students with MID due to variation in ways of defining and labeling intellectual disability, and thus researchers face dilemmas when determining criteria for participant inclusion (Sandieson, 1998). In this study, the criteria was based on IQ scores which can be problematic due to variation of student performance that often occurs within the 50–75 IQ range (Cawley & Parmar, 1995; Fletcher, Blair, Scott, & Bolger, 2004). However, the researchers chose IQ for determination of inclusion of participants due to the ambiguity of the MID label especially when considering studies done outside the United States where a student can be labeled as having MID due to having an IQ of up to 85 in countries (e.g., the Netherlands). While it is necessary to be specific about participant characteristics when reporting findings, the drawback of excluding studies done in foreign countries, as well as following strict guidelines for participant IQs, is the exclusion of some important studies in mathematics for students with disabilities completed recently by researchers in other nations (e.g., Chung & Tam, 2005; Kroesbergen & Van Luit, 2003; Kroesbergen & Van Luit, 2005). Therefore, some important studies to the field may have been excluded due to the strict, yet necessary, inclusion criteria set by the researchers in this study.

Aside from difficulties with defining and labeling students with MID, the lack of information on characteristics of students with MID also presents a challenge. To better study students with MID, it may be necessary to more thoroughly investigate the characteristics of students with MID by specifically studying this population (as in Schuchardt et al., 2010) rather than aggregating data with other populations which is a common problem and has made it difficult to determine the characteristics and outcomes for students with MID (Polloway et al., 2010). Also, due to the lack of research on mathematics and students with MID, it may be important for researchers to examine the performance of these students using qualitative research designs to gain insight into the specifics of how students with MID understand and reason about mathematics. After a foundation of research regarding mathematical reasoning as well as the characteristics (e.g., memory and processing abilities) of students with MID has been established, interventions may be more effectively developed. Eventually, considering that teachers are expected to use evidence-based practices to guide their instruction, researchers need to provide a more thorough research base regarding effective interventions for students with MID so teachers can have a better foundation upon which to build their instructional practices.

References

* Indicates articles used in this review of the literature


Algozzine, B., O’Shea, D. J., Crews, W. B., & Stoddard, K. (1987). Analysis of mathematics compe-


Jimenez, B. A., Browder, D. M., & Courtade, G. R. (2008). Teaching an algebraic equation to high school students with moderate developmental dis-


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